

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: TORU TAKAMIZAWA ET AL.

Serial No.: 08/620,541

Group Art Unit: 3503

Filed: MARCH 25, 1996

Examiner: Lenard A. Footland

Title: PRELOADING METHOD FOR PRELOAD-ADJUSTABLE
ROLLING BEARING AND MANUFACTURE OF THE SAME

SUPPLEMENTAL AMENDMENT UNDER 37 C.F.R. § 1.115

Assistant Commissioner for Patents
Washington, D.C. 20231

COPY

Sir:

This supplements the Amendment filed on July 29, 1997. The following amendments and remarks are respectfully submitted in connection with the above-referenced application in response to the Office Action mailed January 29, 1997.

IN THE CLAIMS:

Please amend the claims as follows:

-- 58. (Twice Amended) A preload-controllable bearing apparatus comprising first and second members which are rotatable relative to each other,

the first member having [spaced apart] first and second [raceways] raceway portions which are [axially] fixed in a direction to come closer relative to each other with reference to the first member,

the second member having [a first race with] a third raceway portion which is opposed to the first raceway portion of the first member with a first ball row therebetween, and [a second race with] a fourth raceway portion which is opposed to the

second raceway portion of the first member with a second ball row therebetween,

[the first race with] the third raceway portion being fixed [relative to the second member and being axially] in a direction to be separated from [the second race with] the fourth raceway portion with reference to the second member,

[the second race with] the fourth raceway portion being fitted to the second member with an interference so as to be movable relative to each other,

the interference causing a force against movement which is larger than the axial reaction force to a preload to be exerted through the first raceway portion, the first ball row, the third raceway portion, the fourth raceway portion, the second ball row, the second raceway portion and the first raceway portion,

the preload being adjustable based on an axial pressure to be applied to between the fourth raceway portion and the second member,

the first member being an outer ring while the second member being a shaft extending through the outer ring, and

[at least one of] the third and fourth raceway portions [first and second races] being an independent member fitted to the shaft.

59. (Twice Amended) A preload-controllable bearing apparatus comprising first and second members which are rotatable relative to each other,

the first member [having spaced apart] first and second [raceways] raceway portions which are [axially] fixed in a direction to come closer [relative] to each other with reference to the first member,

the second member having [a first race with] a third raceway portion which is opposed to the first raceway portion of the first member with a first ball row therebetween, and [a second race with] a fourth raceway portion which is opposed to the second raceway portion of the first member with a second ball row therebetween,

[the first race with] the third [raceway] and [the second race with the] fourth raceway portions being fitted to the second member with an interference so as to be movable relative to each other,

the interference causing a force against movement which is larger than the axial reaction force to a preload to be exerted through the first raceway portion, the first ball row, the third raceway portion, the fourth raceway portion, the second ball row, the second raceway portion and the first raceway portion,

the preload being adjustable based on an axial pressure to be applied to between the third raceway portion and the fourth raceway portion,

the first member being an outer ring while the second member being a shaft extending through the outer ring, and

[at least one of] the third and fourth raceway portions [first and second races] being an independent member fitted to the shaft.

60. (Three Times Amended) The preload-controllable bearing apparatus of Claim 58 or 59, wherein [each of] the [raceways] raceway portions has an arcuate shape in cross section.

61. (Three Times Amended) The preload-controllable bearing apparatus of Claim 58 or 59, wherein the fourth raceway portion [second race] has a first side face and the third raceway portion [first race] has a second side face such that the first and second side faces are opposed to each other with a gap therebetween.

63. (Three Times Amended) The preload-controllable bearing apparatus of Claim 58 or 59, wherein the [raceways] raceway portions are a type of deep groove.

67. (Twice Amended) A preload-controllable bearing apparatus comprising first and second members which are rotatable relative to each other,

the first member having [spaced apart] first and second [raceways] raceway portions which are [axially] fixed in a direction to come closer relative to each other,

the second member having [a first race with] a third raceway portion which is opposed to the first raceway portion of the first member with a first ball row therebetween, and [a second race with] a fourth raceway portion which is opposed to the second raceway portion of the first member with a second ball row therebetween,

[the first race with] the third raceway portion being fixed [relative to the second member and being axially] in a direction to be separated from [the second race with] the fourth raceway portion with reference to the second member,

[the second race with] the fourth raceway portion being fitted to the second member with an interference so as to be movable relative to each other,

the interference causing a force against movement which is larger than the axial reaction force to a preload to be exerted through the first raceway portion, the first ball row, the third raceway portion, the fourth raceway portion, the second ball row, the second raceway portion and the first raceway portion,

the preload being adjustable based on an axial pressure to be applied to between the fourth raceway portion and the second member,

the first member being an outer ring while the second member being a shaft extending through the outer ring, and the [raceways] raceway portions having an arcuate shape in cross section.

68. (Twice Amended) A preload-controllable bearing apparatus comprising first and second members which are rotatable relative to each other,

the first member having [spaced apart] first and second [raceways] raceway portions which are [axially] fixed in a direction to come closer relative to each other,

the second member having [a first race with] a third raceway portion which is opposed to the first raceway portion of the first member with a first ball row therebetween, and [a second race with] a fourth raceway portion which is opposed to the second raceway portion of the first member with a second ball row therebetween,

[the first race with] the third [raceway] and [the second race with the] fourth raceway portions being fitted to the second member with an interference so as to be movable relative to each other,

the interference causing a force against movement which is larger than the axial reaction force to a preload to be exerted through the first raceway portion, the first ball row, the third raceway portion, the fourth raceway portion, the second ball row, the second raceway portion and the first raceway portion,

the preload being adjustable based on an axial pressure to be applied to between the third raceway portion and the fourth raceway portion,

the first member being an outer ring while the second member being a shaft extending through the outer ring, the [raceways] raceway portions having an arcuate shape in cross section.

69. (Three Times Amended) The preload-controllable bearing of Claim 67 or 68, wherein the fourth raceway portion [second race] has a first side face and the third raceway portion [first race] has a second side face such that the first and second side faces are opposed to each other with a gap therebetween.

75. (Three Times Amended) The preload-controllable bearing of Claim 67 or 68, the third and fourth raceway portions [first and second races each] being an independent member fitted to the shaft. --

REMARKS

Upon further review of the previous amendments and remarks, Applicants believe that some clarification is in order. Applicants withdraw the previous remarks. The Examiner has rejected the present application referring to Kitahara et al. (Patent No. 4,900,958). Specifically, the Examiner merely pointed to Fig. 8 and column 7, lines 22-24 of the Kitahara patent. With reference to this rejection, applicants explain the differences between the present invention and the Kitahara et al. invention as follows:

The present invention has a common point to the Kitahara et al. invention in applying a preload to a bearing to prevent the whirling and axial trembling in the precise rotating devices such as HDDs using the bearing. The purpose of applying the preload to the bearing is to eliminate play from between the balls and races in the bearing and to eliminate chattering in the bearing.

However, Kitahara et al. never disclose nor describe any specific structure to apply the preload to the bearing as in the present invention.

The following are statements on this point.

1. In Fig. 8 of Kitahara et al., an example of the inner and outer rings of the lower bearing 61 is shown to be fixed to the shaft and to the frame, respectively, with press fitting. The reason of the press fitting is believed in eliminating plays from between the bearing and the shaft and frame to prevent the whirling in the device using this bearing. Because, if there is play here, in spite that the preload is applied to the bearing to eliminate the play from between the balls and the races, the whirling in the device using this bearing could not be prevented, and therefore the effects of applying the preload to the bearing could not hopefully be provided.

2. In Fig. 8 of the Kitahara et al. patent, the play between the bearing and the shaft and frame is eliminated with slight press fitting or adhesion bonding.

3. In Fig. 8 of the Kitahara et al. patent, if it is merely to axially position the inner rings 62 of the lower

bearing 61, there is no need of press fitting the inner ring 62 of the lower bearing 61 nor of fixing the same with adhesion.

4. However, it is believed that the press fitting and adhesion bonding are provided in order to prevent the whirling in the Kitahara et al. patent, and if this is true, the amount of press fitting is satisfied with slight interference enough to eliminate the play.

5. In the structure as of Fig. 8 of Kitahara et al. where the lower and upper bearings are mounted vertically between the shaft and the rotor housing, if the friction resistance is larger than the preload on the balls, upon assembling the device by forcing the lower and upper bearings between the shaft and rotor housing, the forces to provide relative sliding between the shaft and upper inner ring, between the upper outer ring and frame, between the lower outer ring and frame, and between the lower inner ring and shaft, are transmitted through the balls, as in the course of upper inner ring, balls, upper outer ring, spacer, lower outer ring, balls and lower inner ring, resulting in an excessive pressure on the balls, and leaving dent flaws on the balls, which causes noise.

6. Accordingly, the amount of press fitting in the bearing in Fig. 8 of the Kitahara et al. patent is understood to be as small as for eliminating the play in order to prevent the whirling.

7. The description on Fig. 8 of the Kitahara et al. patent is merely directed to the state where the two bearings are

subjected to preload, and there is no description about how specifically the preload is applied to the bearing, and how the preload is fixed.

Although it is felt that descriptions are made in eliminating radial play from the inner and outer rings of the lower bearing and fixing these members with slight press fitting or adhesion enough to prevent the whirling, particularly about the inner ring of the upper bearing which is important for applying the preload to the bearing, there is no specific disclosure about how the axial preload is applied, and how the preload is fixed axially.

In summary, the description on Fig. 8 is made without considering any specific method of applying the preload to the bearing.

8. Incidentally, with respect to the method of applying such preload to the bearing, there is a specific description on the example of Fig. 9. That is, a specific structure is disclosed where the upper inner ring is pushed with a force from outside, and the inner ring is kept stationary axially opposing to the preload reaction force from the balls even if the outside force is removed, which is adhesion fixing. In addition, it is described at column 7, lines 39-42 that the difference between Fig. 8 and Fig. 9 is in replacing the spacer by projection, and therefore it is believed that Fig. 9 shows a specific example of applying a preload to the bearing of Fig. 8.

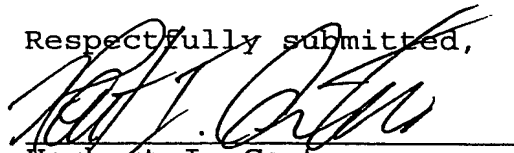
9. From what is described above, there is no disclosure in the Kitahara et al. patent on the point that "the force due to interference against movement on the portion fitted with relatively movable interference is larger than the preload reaction force axially exerted" as in the present invention.

In light of the foregoing amendments and remarks, this application should be in condition for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #313KA/36119CO).

August 19, 1997

Respectfully submitted,


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